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Lubrication

STACKS

A Technical Publication Devoted to
the Selection and Use of Lubricants

THIS ISSUE

Machine Tool Lubrication
on the
Production Line



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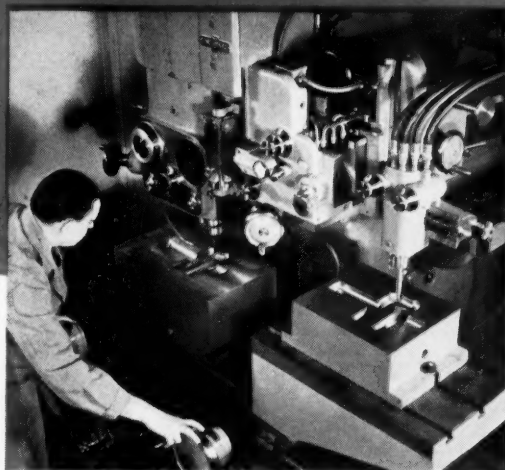
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LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

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Machine Tool Lubrication on the Production Line

IF AUTOMOBILES were made today with the machine tools of 1910, a single vehicle with 1949 refinements, would cost \$60,000" — thus estimated the Automobile Manufacturers Association recently. What a tribute to the advancements made in machine tool design during the last forty years.

Just as spectacular has been the development of petroleum technology during this same period. Modern refining methods so necessary to remove undesirable components of petroleum products and the use of various additives to fortify or amplify desirable properties are major advancements made during the last several decades.

As is true with practically all industries, advancements made in one usually complement or makes possible advancements in another. The machine tools of today would clatter to a sudden stop if they were lubricated with many of the products available in 1910. On the other hand, petroleum refineries could not be operated at economical costs without modern machine tools to produce the tens of thousands of parts so necessary in their construction and operation.

Machine tools now available are capable of turn-

ing out finished products at speeds and with an accuracy that is astounding. To do this, however, it is necessary that all the parts of a given machine tool function properly. One very important factor contributing to satisfactory performance is effective lubrication. Without this, accuracy may be lost, oils may overheat causing temporary misalignment of machine parts, or metal to metal contact may occur causing rapid wear or complete seizure between moving parts.

Important too is the length of time the lubricant "stays put" in the machine. Most lubricants today—both greases and oils — are manufactured so as to withstand oxidation and other deteriorating factors for much longer periods than was possible only a few years ago.

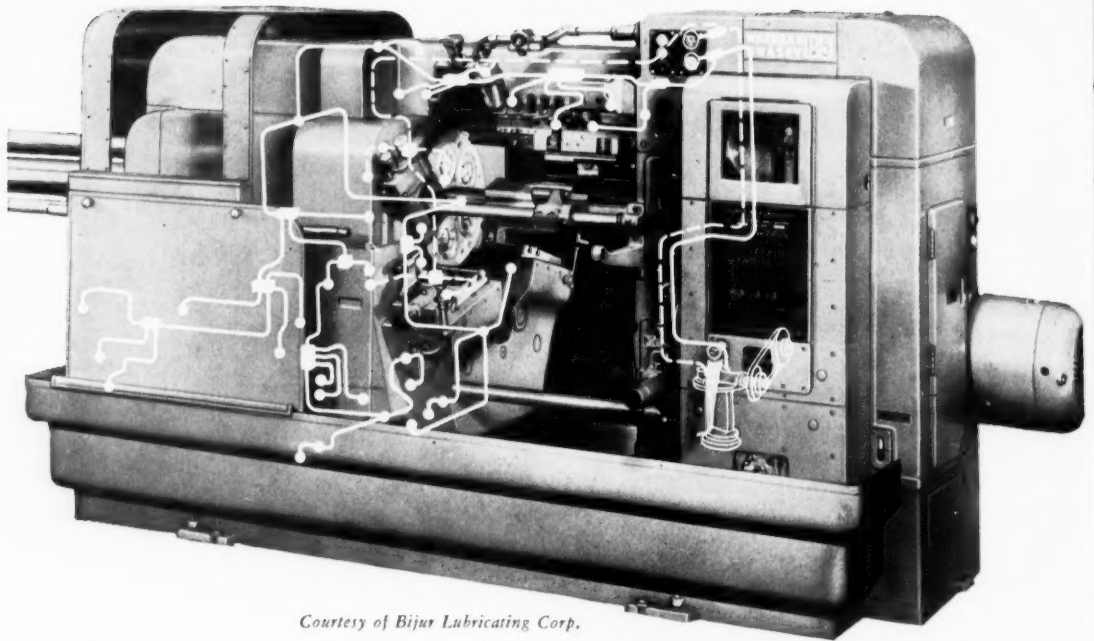
Another important factor in machine tool lubrication is economy. How can the best economy in lubrication and

maintenance of machine tools be obtained? — By intelligent lubrication, namely

1. The use of the right product for each requirement.
2. By applying quality lubricants designed to prevent wear and the formation of gum, sludge,

A SIMPLIFIED Lubrication Plan For Machine Tools: — the theme of this article, presents a means for maintaining quality lubrication, yet reducing costs of maintenance and the total number of lubricants used in a given production shop to a minimum.

The formulation of a simplified lubrication plan must of necessity include a thorough understanding of the operating characteristics of machine tools and an intimate knowledge of lubricant recommendations issued by individual machine tool builders. Such a plan could not be effective without the availability of recently developed lubricants, particularly of the additive type. These lubricants can be used over a much wider range of operating conditions than was possible with lubricants available not too long ago.



Courtesy of Bijur Lubricating Corp.

Figure 1 — Automatic lubrication system for oiling this five spindle automatic bar machine manufactured by The Warner & Swasey Company.

rust or foam, any of which, if permitted to develop, can cause excessive maintenance bills.

3. By making use of a simplified lubrication plan to reduce inventories and minimize the possibility of costly errors due to a mix-up in products used.

It is the purpose of this article to present a simplified lubrication plan for relatively large groups of machine tools, to explain recent developments in such tools which affect lubrication and to show how economies may be effected by the use of modern, quality-type lubricants available today.

IMPORTANCE OF EFFECTIVE LUBRICATION

Effective lubrication of machine tools means much more than the use of the correct grade of lubricant at the right place in sufficient quantity to adequately lubricate moving surfaces. It includes also the use of products which will function over long periods of time without appreciable changes in their physical or chemical characteristics, the use of efficient filters where necessary to keep out contaminants, the application of the minimum amount of lubricant necessary to prevent wastage, and other similar factors. Only when all such conditions are taken into consideration can lubrication be assured which will result in continuous trouble-free operation over long periods of time at a minimum cost.

The present era has focussed much more attention on lubrication than ever before. Primarily, this is due to two factors:

- (a) The rising cost of maintenance which favors automatic and positive means of re-lubrication.
- (b) The development of precision machines capable of much higher rates of production.

The latter, particularly, has been responsible for increased attention being given to more careful selection of lubricants.

It is unnecessary for machine tool operators to determine the grade of product to be used for each bearing or gear in all the machine tools he operates. This responsibility, and rightfully so, lies with the machine tool manufacturer and lubricant supplier. In years gone by, many machine tool manufacturers made no lubricant recommendations at all, or at least, only very meager ones. Even though this condition still exists today with some manufacturers, the majority issue lubrication instructions giving explicit advice as to proper lubrication of their machines. Such instructions are prepared as a result of tests made by the manufacturer, usually in cooperation with lubrication engineers from one or more producers of petroleum products.

Regardless of the diversity of such manufacturers' recommendations, in any production plant containing numerous machine tools it is necessary

LUBRICATION

and economical to reduce the total number of lubricants used to an absolute minimum. Many plants employ a lubrication engineer, and if so, this is his responsibility. In the majority of production shops, however, no employed lubrication engineer is available and in such cases consolidation is sponsored by the oil supplier.

One of the factors which has made possible the consolidated or simplified plan presented herewith is the tremendous advancement made in the quality of petroleum products during the last decade. As a result of improvements made in greases, for example, only one grease is normally employed now to meet all grease requirements in a specific production shop. For this reason, as a required prerequisite to any simplified plan, it is necessary that the types of products available today be clearly known.

Quality of Lubricants

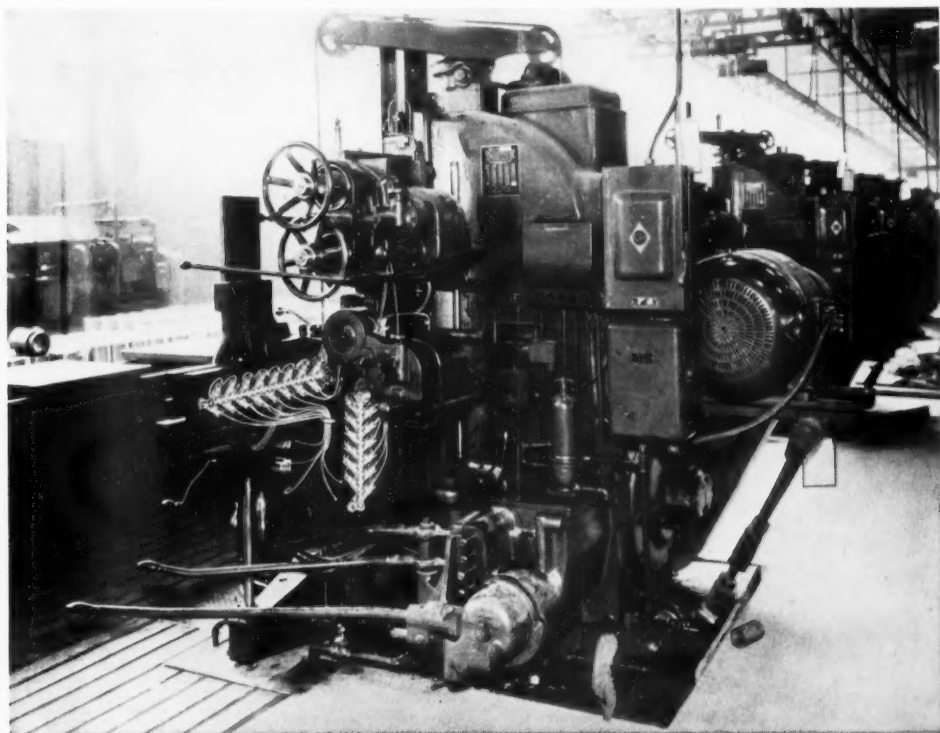
Modern machine tools equipped with anti-friction bearings and precision gears operating with close tolerances and at high speeds, are in the majority of cases equipped with splash, bath, or centralized lubricating systems. Such systems require the use of the highest quality lubricants. Experience has shown that the use of "quality"

products reduces maintenance costs, and improves machine performance.

Oils used in reservoirs should be so refined that they are highly resistant to oxidation — otherwise gum or sludge may be formed, resulting in unnecessary down time to clean out the machine. In addition it is highly desirable that their properties be further fortified by the incorporation of additives. Depending upon the type of oils used and the properties needed, various present day oils contain additives to improve oxidation resistance, to prevent rust formation, to overcome foaming due to entrained air and to increase extreme pressure, oiliness, or adhesive qualities.

The acceptance of the use of additives in petroleum lubricants is shown by the fact that in the last fifteen years the additive manufacturing industry has grown until now approximately 1,500 barrels of additives are produced per day with an annual value of \$35,000,000.00. The many benefits to be derived by the use of additives in lubricants will be discussed in detail under various ensuing sections.

Cheaper or second grade oils are still used on some machine tools, particularly machines which are rather old. Such oils are satisfactory for "once through" lubrication points such as oil cups, oil holes, wick feed and similar oiling methods where



Courtesy of Alemite Division, Stewart-Warner Corporation

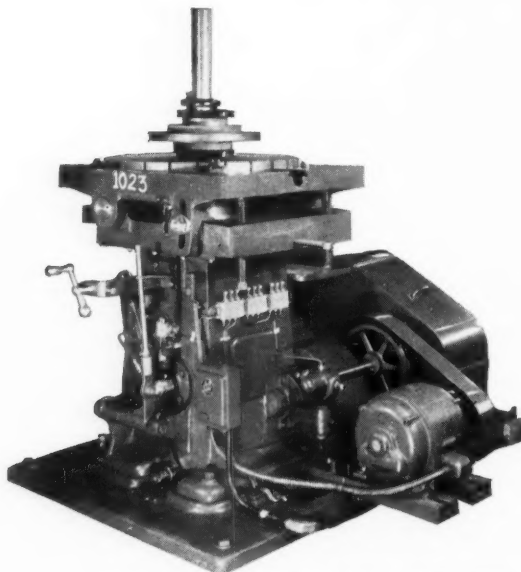
Figure 2 — Portion of a grease dispensing system on a Bullard vertical turret lathe.

the oil makes a single pass through the bearing. Even with older machines predominantly lubricated by oil cups, however, it is often desirable to use quality lubricants. Such machines are usually in a minority in any given shop and stocking of two oils of the same viscosity, one a high grade for reservoirs and the other a cheaper grade for oil cups, proves more expensive in the long run.

Viscosity

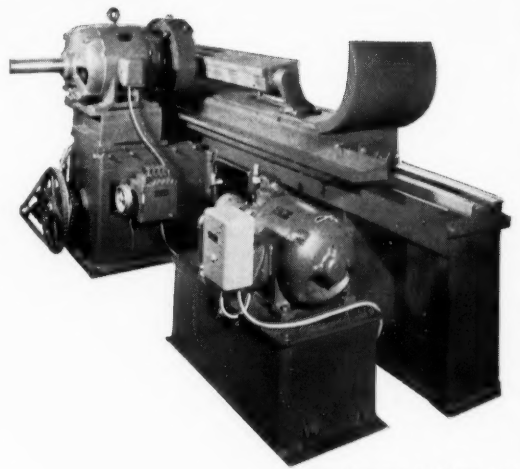
The importance of using the correct viscosity or grade of oil cannot be overstressed in the lubrication of modern precision machine tools. In older machines, or in tools which do not produce work to close tolerances, viscosity is less important and oils with a rather wide range of viscosities may be used with entire satisfaction.

On close fitting parts used so prevalently in modern tools the viscosity should be kept within the limits specified by the manufacturer. Obviously, it should not be so low that metal to metal contact might occur. The use of an oil having too high a viscosity also has several disadvantages. Internal friction developed in the oil can cause it to overheat, resulting in more rapid oil deterioration and heating up of the metal parts surrounding the oil. The latter is particularly troublesome on machines working to very close tolerances for the excessive heat generated may be sufficient to expand the frame of the machine, or parts thereof to such an extent that the cutting tools or work must be reset periodically.



Courtesy of The Farral Corporation

Figure 3 — Centralized oiling system on a Mitts & Merrill No. 5 Key Seater.



Courtesy of Mammel Inc.

Figure 4 — A four feed automatic lubricator used to lubricate the ways of this knife grinder manufactured by Samuel C. Rogers & Co.

SIMPLIFIED LUBRICATION PLAN

Simplification and economy are intimately related in so far as the lubrication of machine tools is concerned.

Progressive machine tool operators are constantly endeavoring to reduce the total number of lubricants required for the proper lubrication of their machines. This has been influenced in recent years by several factors, including the increasing cost of maintenance, the necessity of reducing overhead expenses and primarily, the availability of newer types of lubricants which are capable of functioning under wide varieties of conditions.

The primary purpose of this article is to present a simplified lubrication plan for machine tools. This plan takes into account all of the above factors. Briefly, it presents a method for consolidating the number of lubricants used in a given production shop to an absolute minimum. Specifically, the products recommended in this plan are shown in Table I.

This consolidated or simplified list of lubricants for large production shops, was developed as a result of a study of all machine tool manufacturers' lubricant recommendations and extensive field experience obtained with the types of products recommended. This list will apply to the great majority of machine tools in use today. (In a few instances, however, specialty products may be required.) Even all the products listed may not be necessary in a given production shop; for example, the use of two greases, two hydraulic oils or several way lubricants and spindle oils may be unnecessary.

In order that the recommendations made may be understood more clearly each is discussed in detail in the following sections.

LUBRICATION

<i>Parts To Be Lubricated</i>	<i>Approximate Grade (Unless Otherwise Shown in Sec. Say, Unit. Viscosity)</i>	<i>Product Description</i>
Hydraulic System Low Viscosity Medium Viscosity	150 at 100° F. 300 at 100° F.	Hydraulic oil inhibited against rust, oxidation and foam
General Machine Lubricant Low Viscosity Medium Viscosity High Viscosity	200 at 100° F. 300 at 100° F. 500 at 100° F.	High quality mineral oil, preferably inhibited against oxidation, rust and foam
Gears (Not lubricated by general machine oil) Lightly Loaded — Other Than Worm Heavily Loaded — Other Than Worm All Worm Gears	SAE 90 or 140 SAE 90 or 140 SAE 90 or 140	High quality mineral oil Lead soap base, non-corrosive, mild type, extreme pressure lubricant
Spindles Oil Lubricated By Oilers and Wick Feed By Ring Oilier By Circulating of Flood System By Oil Mist Grease Lubricated	100-200 at 100° F. 200-300 at 100° F. 40-300 at 100° F. 40-150 at 100° F. NLGI Grade No. 2	High quality mineral oil High quality mineral oil, preferably inhibited against rust and oxidation Mixed base (sodium-calcium) premium grade anti-friction bearing grease, highly resistant to oxidation
Ways Lightly Loaded Medium Viscosity High Viscosity Heavily Loaded, or where Chattering Occurs Medium Viscosity High Viscosity	300-500 at 100° F. 700-1000 at 100° F. 300 at 100° F. 1000 at 100° F.	Well refined straight mineral oil, or use general machine lubricant, if viscosity same Oils containing oiliness and extreme pressure qualities, as well as ability to withstand pressing out
General Grease Lubrication Normal Operation Heavy Duty Operation	NLGI Grade No. 2 NLGI Grade Nos. 1 or 2	Mixed base (sodium-calcium) premium grade anti-friction bearing grease, highly resistant to oxidation Sodium base grease made with refined residual oils
Dual and Tri Purpose Oils for Multiple Spindle Automatic Screw Machines Dual Purpose — Machine Lubricant and Cutting Fluid Tri Purpose — Hydraulic Fluid, Machine Lubricant and Cutting Fluid	150 at 100° F. 260 at 100° F.	Non-corrosive sulphurized mineral oil

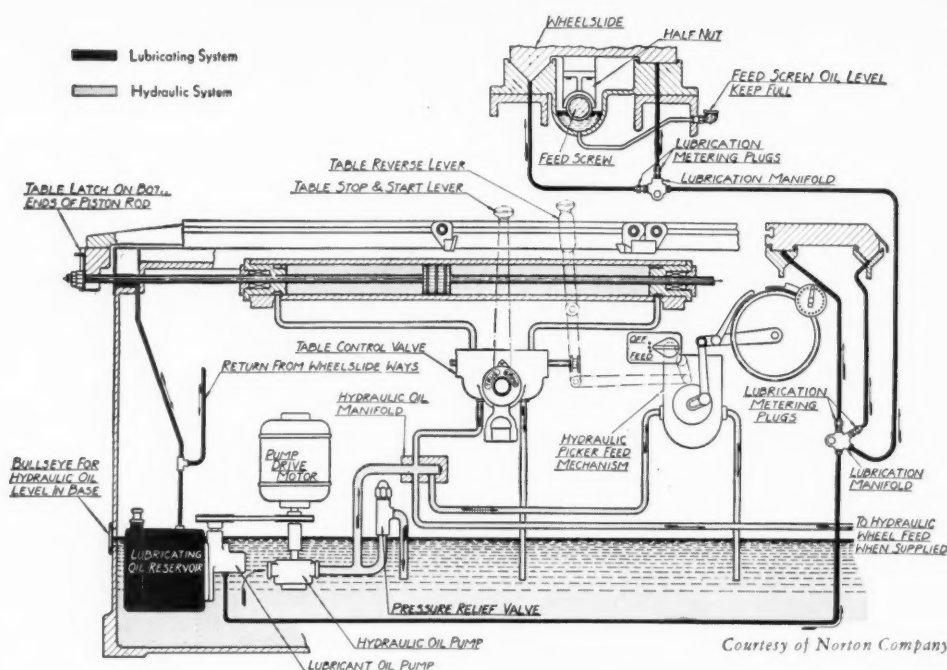


Figure 5 — Schematic plan of hydraulic and lubricating system of a 6" Type C Cylindrical Grinding Machine.

Hydraulic Systems

Probably nowhere on a machine tool can trouble occur as often as in the hydraulic system if accepted maintenance procedures are not followed. These include the use of the correct grade of oil with a quality commensurate to demands placed on the oil by the hydraulic system.

Many factors contribute to the need of special care in selecting hydraulic oils. Conditions which cause oils to oxidize present one of the foremost. These conditions include operating temperatures ranging up to 150° F. or even higher in a few instances, severe agitation at each pass through pumps and valves, pressure, the presence of metallic catalysts and unfortunately in some instances various contaminants such as cutting oils. As a result, inhibitors are now incorporated in hydraulic oils to retard oxidation; their effectiveness being phenomenal. Field experience has shown that intervals between drain periods may be increased many times over that obtained with straight mineral oils, and more important the possibility of gum or sludge formation in the system is almost entirely eliminated.

Rust formation in hydraulic systems is another factor contributing to poor hydraulic system performance. Rust can be caused by condensation of moisture in the reservoir, contamination such as from coolants, or leaking water coolers. Fortunately, rust formation can be prevented by the addition of small amounts of inhibitors to the oil. These

inhibitors "plate out" on metal surfaces, forming a film which is impervious to the rusting action of moisture and air.

A third factor is foaming, which is troublesome in some systems. Here again, it is possible to so treat or process the oil that any entrained air in the oil is quickly separated. The presence of air in hydraulic oils can result in erratic motion of actuated parts, can cause the oil to oxidize more rapidly and if foam is formed in the reservoir the probable overflow is unsightly and a safety hazard.

During the last several years the economy of using high quality inhibited type hydraulic oils has been proven time and time again. Little wonder they are used almost exclusively today in machine tool hydraulic systems.

Mention has previously been made that viscosity is an important consideration in the selection of oils. Since pumps are the most critical part of a hydraulic system in so far as lubrication is concerned, pump manufacturers have made extensive tests to determine what viscosity oil performs best in systems containing their pumps. It is necessary that the viscosity be sufficiently high to prevent metal to metal contact and to give high volumetric efficiencies, yet it must be low enough to pump easily so that pressure drop through the system is at a minimum. For these reasons pump manufacturers issue specifications indicating the correct viscosity to be used under various operating conditions.

Fortunately, practically all hydraulic pumps used on machine tools require the use of two grades or viscosities of oil, one being 150 and the other approximately 300 seconds at 100° F. Say. Univ. For this reason, two grades of hydraulic oil are shown in Table I, but perhaps only one may be necessary in a given production shop.

General Machine Lubricant

Relegated to history is the general use of oil holes, oil cups or other manual means of applying oil to modern production machine tools. In the place of such devices centralized pressure, splash or similar forms of lubrication are now almost universally accepted. The great majority of production machines built today are so lubricated that little or no attention is required at time intervals ranging from a minimum of once a shift to long periods of time. Even machines lubricated once each shift are for the most part equipped with so called "one shot" systems where it is necessary merely to pull out a knob to relubricate the machine.

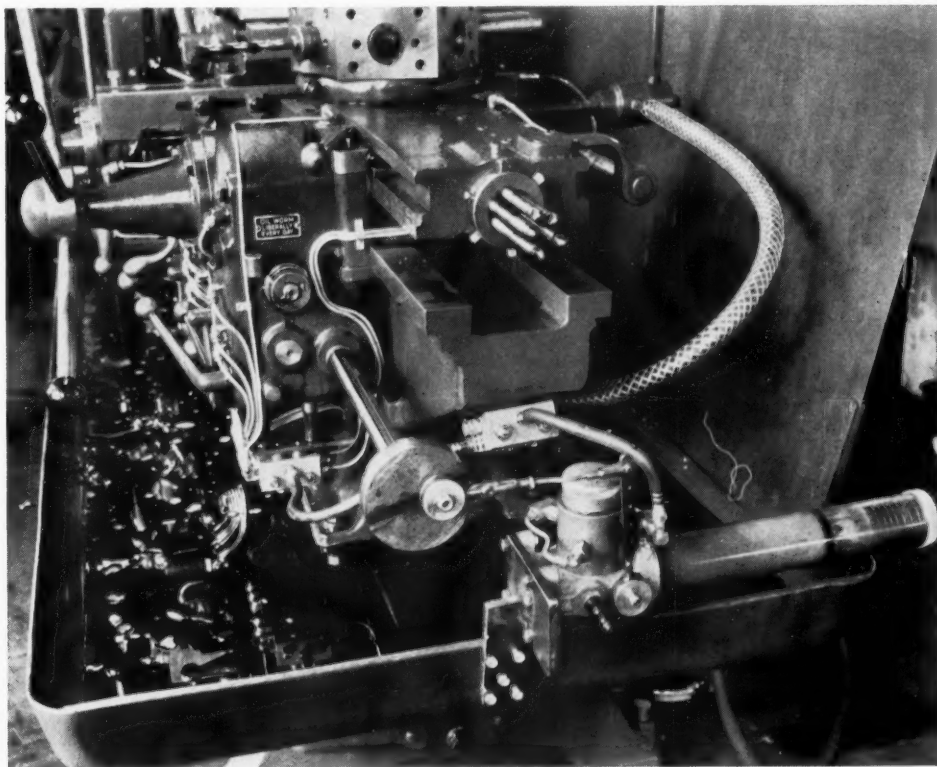
Centralized systems range from "one shot" to completely automatic systems in which it is merely necessary to periodically replenish the reservoir with oil. Applications of such systems to machine

tools are shown in the illustrations accompanying this article.

Even though automatic lubrication is a feature of almost all production machines, remote spots which cannot otherwise be lubricated economically, may require application of oil by sight feed oilers or oil cups. These *must not be overlooked* when relubricating.

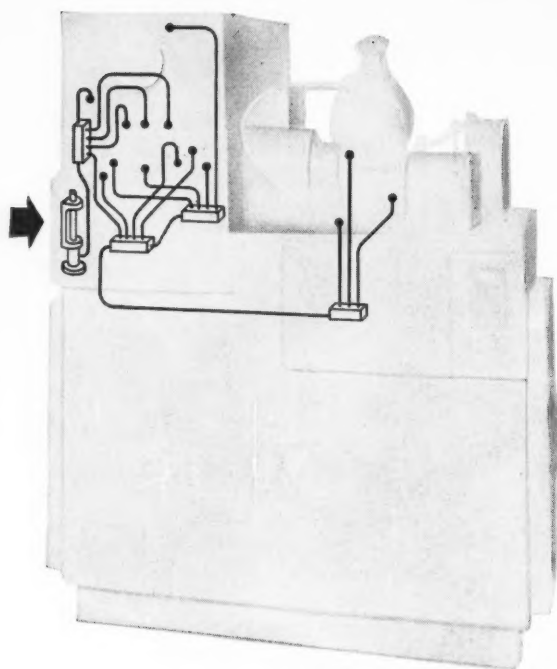
Just as the use of automatic lubricating systems has become so common during the last few years, so has the use of inhibited lubricating oils for general machine lubrication. In fact some operators have found that using inhibited hydraulic oils for general machine lubrication has saved them money in maintenance and down time costs. One reason is that rusting is a detrimental factor in humid atmospheres and of course this can be overcome by the use of rust inhibited oils. The possibility of gum or sludge formation as the result of oil oxidation, and foaming caused by air being beaten into the oil are other detrimental factors which can be overcome by using inhibited oils instead of straight mineral oils.

A fourth type of additive currently coming into specialized usage imparts extreme pressure characteristics. Oils containing such additives are now



Courtesy of Trabor Engineering Corporation

Figure 6 — Centralized grease lubricating system on a turret lathe. Note pump and reservoir located in lower right hand corner and mounted in a horizontal position.



Courtesy of Bijur Lubricating Corp.

Figure 7 — Automatic oiling system for a thread generator made by The Fellows Gear Shaper Company.

specified by several manufacturers whose tools contain heavily loaded bearings. Typical types of machine tools include some grinders for crush dressing, centerless thread grinders, and vertical turret lathes.

The great majority of machine tools require the use of a general machine lubricant having a viscosity of approximately 300 or 500 seconds Say. Univ. at 100° F. However, certain tools, may require an oil having a viscosity of only 200 seconds at 100° F. In general the lower the viscosity, the less will be the heat generated by internal friction in the oil. Low viscosity oils are used where distortion of machine parts, caused by oil heating, must be minimized.

Based on present indications there are certain definite trends in general machine lubrication, i.e.

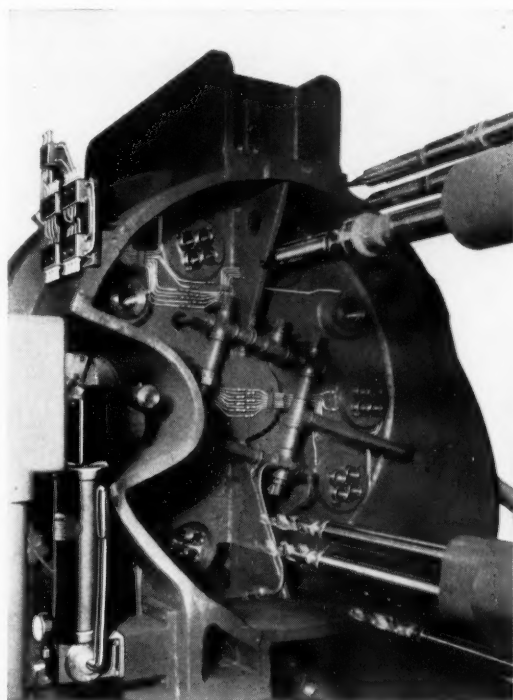
- (1) the ever increasing use of automatic lubricating systems
- (2) general acceptance of machine lubricants containing inhibitors to prevent oil oxidation, rust and foaming
- (3) an increase in the use of extreme pressure agents in oils for use on certain types of machines
- (4) a general lowering in the viscosity of the oil used as machines tolerances are decreased.

Gears Other Than Those Lubricated by the General Machine Lubricant

Some machine tools are equipped with gears which require a much higher viscosity product than that used as a general machine lubricant. Typical examples are found on some back gears of vertical or larger type horizontal turret lathes, column mechanisms of milling machines, screw mechanisms on boring mills, etc. Such products usually fall within the SAE-90 or 140 viscosity grade, and the specific viscosity and type of product required is normally specified by the machine builder.

Gear lubricants in so far as type is concerned, fall within two classifications, straight mineral oil and extreme pressure lubricants. Straight mineral oil type gear lubricants should be well refined and highly resistant to oxidation. In addition, they should be so processed that they do not foam when mixed with air, or emulsify when contaminated with water.

With respect to extreme pressure gear lubricants, the lead soap base type has been outstanding. This type is non-corrosive to copper or steel, has a high film strength, is unaffected by presence of moisture and does not thicken or oxidize appreciably in service. Lead soap base extreme pressure lubricants



Courtesy of The Farral Corporation

Figure 8 — A centralized oiling system on a special horizontal drum type Barnes drill.

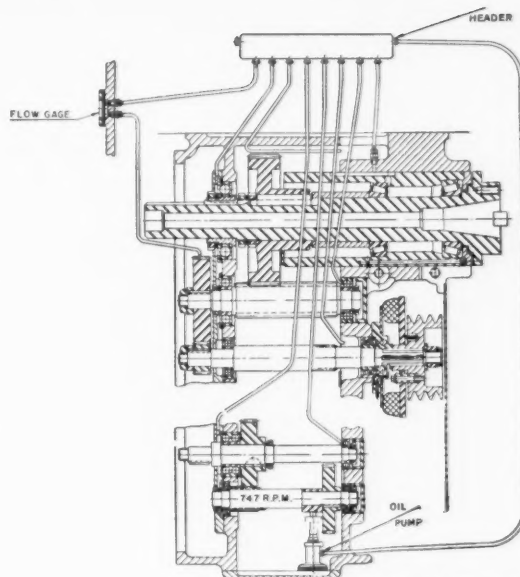
are recommended for use on all types of gears, including worm gears, for use on anti-friction bearings contained in the gear case, on screws, and similar applications. For these reasons, this type is often used where both straight mineral and extreme pressure gear lubricants are specified by various manufacturers for their tools in a specific production shop in order to simplify the number of products used.

Sulfur-chlorine, "mild" type extreme pressure lubricants can also be used on gears but before doing so it should be ascertained if they are corrosive, or will stain steel or copper.

Gear lubricants are normally contained in reservoirs, the gears being lubricated by splash or by a forced feed system. A few specialized machines contain what are termed open gears, that is, they are not contained in an oil tight housing. In such cases, it is necessary that an adhesive type gear lubricant be applied directly to the gears. Such products are made from heavy residual stocks and are sufficiently adhesive and cohesive that they will not throw off.

Spindles

High speed spindles on grinders and similar types of tools require extreme care in the selection



Courtesy of Sundstrand Machine Tool Co.

Figure 10 — Automatic lubrication for gear train and spindle in a No. 33 Rigidmill. The oil pump actuated by an eccentric on the lower shaft delivers oil to the header from which it is delivered to individual bearings by tubing as indicated. Note the flow gage through which visual observation will show that the distribution system is functioning properly.

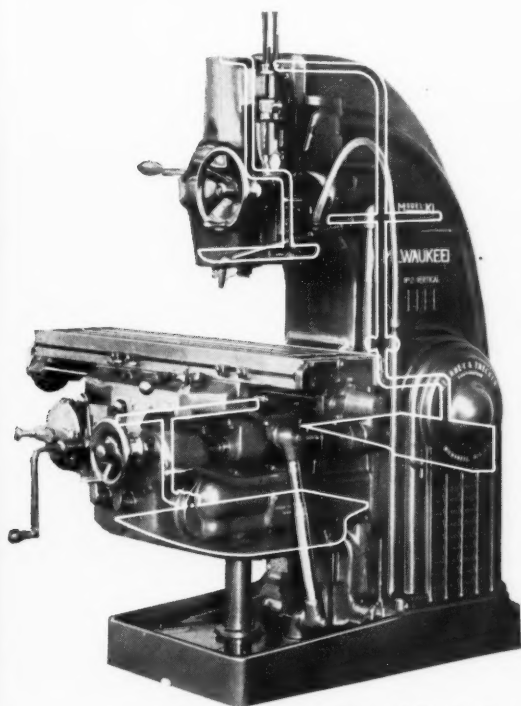
of the proper lubricant. Spindles may be either grease or oil lubricated depending upon the design.

With respect to oil lubricated spindles, speed and load on the bearings are two primary considerations in the selection of a proper lubricant. Other factors, however, such as the type of bearing involved, possibility of contaminants (grinding dust for example) entering the bearing housing and method of lubricant application also play an important part in the choice of a lubricant.

It is absolutely essential that there be no play in spindles, therefore, clearances are held to a minimum. Also, there has been a definite trend toward higher spindle speeds. As clearances are decreased and speeds increased, it is normally necessary that the viscosity of the lubricant be lowered. It is for this reason that some manufacturers specify very low viscosity oils for spindles.

The reasons for using low viscosity products on modern high speed spindle bearings is simply that if high viscosity products were used, the bearings might overheat and ultimately seize, the hot oil would oxidize more rapidly and the hot metal surrounding the oil would expand, thus affecting the accuracy of the machine.

Spindle bearings range in design all the way from sleeve type bearings to three part bearings (half box located at the bottom and to the rear of



Courtesy of Kearney & Trecker Corp.

Figure 9 — Illustrating how one milling machine is lubricated by force feed from three reservoirs. In each case the oil is circulated to points of application by small pumps.

the spindle housing with two adjustable bearing segments on top), three or five pivoted shoe types and, of course, anti-friction bearings.

Methods of oil lubrication range from the use of sight feed oil cups, spring-actuated wick oilers and ring oilers to flood lubrication and mist application.*

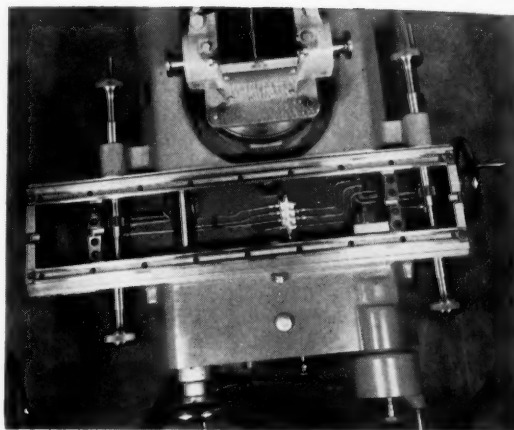
Oil lubricated spindles require products ranging in viscosity from 40 to 300 seconds at 100° F., Say. Univ. depending upon factors discussed above. Although general recommendations can be made, as indicated below, it is best to follow the manufacturers' recommendations as to the correct viscosity of oil to use in a specific spindle. In general sight feed oilers, wick oilers, and ring oilers are to be found on comparatively low speed spindles, whereas flood and mist type lubrication are used on higher speed bearings, with mist being used at very high speeds. Therefore, based on method of oil application the following very broad recommendations can be made:

Method of Oil Application	General Viscosity Range of Oil, Say. Univ. Seconds at 100° F.
Sight feed oilers	100 - 200
Spring-actuated wick feed	100 - 200
Ring oiled	200 - 300
Flood or circulating	40 - 300
Oil Mist	50 - 150

In systems where the oil is circulated to the bearings and back to a reservoir (ring oiled, splash, flood or force feed) it is essential that the product used be of good quality. The oil must be resistant to oxidation, not emulsify with any water of condensation or contamination, and quickly free itself of any entrained contaminants, such as grinding dust. In both circulating systems and with mist lubrication, when applied to anti-friction bearings, it has been found that rust is sometimes a factor which can cause serious bearing damage. In order to overcome this, rust inhibited oils have been resorted to with complete success.

So far, this discussion has concerned oil lubricated spindles only. However, where there is a possibility of oil leakage, or under conditions where dirt, dust and other contaminants can get into the bearing, grease is often used. In such cases, a premium grade anti-friction bearing grease of a No. 2 NLGI consistency, such as described in the section to follow on "Greases", should be used.

No discussion on spindle lubrication would be complete without a word on cleanliness. High



Courtesy of Cincinnati Milling and Grinding Machines, Inc.

Figure 11 — Lubricating lines in the saddle of a No. 2 Cutter and Tool Grinder, with table removed. Oil is fed to the distributor in the center from which it goes to various bearings.

speed spindle bearings can be ruined by small particles of dirt. For this reason, air used in mist lubrication should be filtered to remove entrained dirt and moisture. Every effort should be made, also, to keep contaminants out of circulating oils and if the oil does become contaminated, it should be changed immediately.

Ways

No matter how well a machine tool is designed, if the ways are not properly lubricated accurate machining cannot be accomplished. Off hand, one would think it simple to lubricate two flat or V shaped surfaces upon which a carriage, turret or work rest must ride. Quite to the contrary, however, this is one of the critical points in machine tool lubrication and a great deal of research has been conducted by both machine builders and oil suppliers on this problem. As a result of some of this work, new "special" way lubricants have been developed recently and are receiving ever increasing acceptance.

One of the primary problems encountered on many machine ways was chattering, which caused irregularities in the work being done. Since chattering normally occurs just after motion has been reversed, the most common theory was that on the forward motion oil was wiped off the way, then as motion was reversed the carriage had to traverse a comparatively dry way before the oil supply could be replenished. Another problem was that if the carriage was stopped the lubricant had a tendency to press out with the result that when the carriage was again moved it occurred in a "stick-slip" motion. Chattering predominates on some milling, shaping, grinding and similar type machines where the carriage goes back and forth

*Spindle design and methods of oil application have been discussed in more detail in two previous issues of *Magazine Lubrication*: July 1948—"Metals Grinding Machinery Lubrication", and September 1948—"High Speed Ball Bearing Lubrication".

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at predetermined cycles. "Stick-slip" motion is of primary concern on such equipment as lathes where tools at times are advanced into the work a fraction of an inch.

In addition to overcoming the above problems, a way lubricant must have other properties. To enumerate the more desirable qualities:

1. It should eliminate chatter.
2. It should not press out upon standing.
3. It should contain oiliness and extreme pressure agents to prevent metal to metal contact between localized high spots.
4. The oil film thickness built up should not be sufficiently thick to affect the accuracy of the work being done.
5. It is essential that it be non-corrosive to steel or the copper found in the oil distribution system.
6. It should not plug felt filters found in some centralized systems.
7. It should not wash off or be adversely affected by cutting fluids, coolants or water.

Way lubricants having all the above desirable qualities have been developed and placed on the market in the last several years. Where chattering or "stick-slip" troubles have been encountered with straight mineral oils, oils compounded with fatty material or even lead soap base gear lubricants, these troubles have been eliminated by the use of "special" way lubricants.

A variety of type of lubricants may be used on ways, depending both on the load and method of lubrication. Where loads do not exceed approximately 10 pounds per square inch, a straight mineral oil having a viscosity of about 300 seconds at

100° F. Say. Univ. is used, unless the machine manufacturer specifies a somewhat heavier grade.

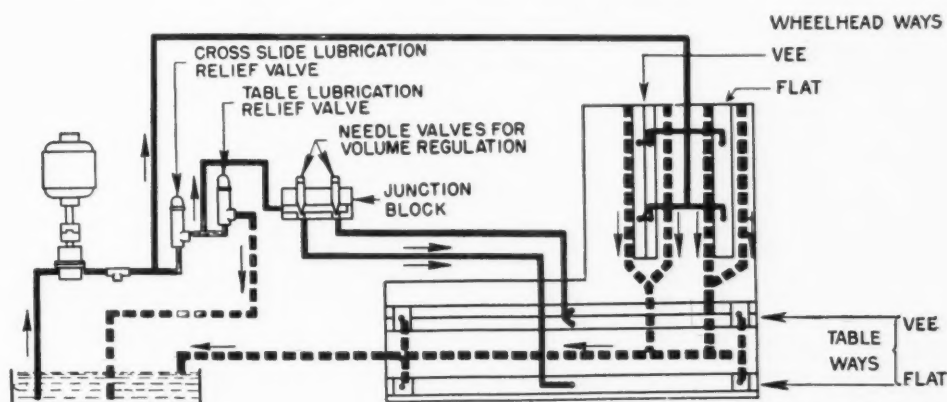
When loads are above 10 lbs. per sq. in. it is usually necessary to use a high viscosity straight mineral oil, or more often, a fortified mineral oil. In the past compounded oils, containing fatty material which increases "oiliness", and various types of extreme pressure gear lubricants have been used, with success ranging from good to only fair. It is confidently believed, however, that the machine tool industry will standardize on the use of special way lubricants such as the type described at the beginning of this section when something more than a straight mineral oil is required.

Cross slide ways and comparatively short ways may be lubricated through oil cups, or by similar methods, but longer ways are almost universally lubricated through "one shot" or other forms of a centralized distribution system. Most are automatic so that on each stroke the ways receive a shot of oil.

Ways on some machines are lubricated from the hydraulic system or headstock. In such instances, small diameter copper tubing conducts the oil from the hydraulic circuit or headstock to the ways. It is necessary that the lubricant serve the dual purpose of hydraulic or headstock and way lubricating oil. At the present time only some light duty machines are designed in this manner and the choice of a suitable lubricant requires specialized attention. In a few instances ways are lubricated by excess cutting fluid splashing on the ways.

Greases

Modern machine tools are predominantly oil lubricated, however, grease is used on electric motors, coolant pumps, on some spindle bearings and on miscellaneous applications such as toggle mechanisms, sliding surfaces (other than ways) and some inaccessible bearings.



Courtesy of Cincinnati Milling and Grinding Machines, Inc.

Figure 12 — Diagram of lubrication system on ways of a 4" Plain Hydraulic Grinder.

Experience has shown it is generally desirable to stock only one grease for all grease applications and in such instances, the type of grease used is dictated by the requirements or high speed grease lubricated spindles or electric motors. In these applications a premium grade No. 2 NLGI grease containing a sodium-calcium mixed base soap, a mineral oil with a viscosity of 150 to 400 seconds at 100° F. Say. Univ. and an inhibitor to retard oxidation is used. Such a product has proven entirely satisfactory on high speed anti-friction bearings such as found on spindles and electric motors and at continuous operating temperatures up to about 250° F. In a few cases, on particularly large or heavy duty equipment a sodium soap base grease containing a high viscosity oil is required, for such a product will withstand heavier loads than will the type recommended for electric motors and spindles.

On many older machines, plain bearings were used extensively and for these an ordinary cup grease was used. Even though many of these machines are still in operation, most operators now use the type of grease required for anti-friction bearings (described above) for such points. It is often found more economical to carry only one grease for all grease lubricated points rather than two greases, one for anti-friction bearings and a cup grease for plain bearings. Some operators have gone so far as to say that the mere possibility of exchanging these two types, resulting in the almost certain failure of high speed anti-friction bearings is sufficient reason to preclude the stocking of a cup type grease for plain bearings.

The application of grease on modern machine tools has been greatly simplified. In the past it was necessary to completely circle the machine to reach all points. The modern trend is definitely toward the use of a centralized distribution system (see accompanying illustrations) or, at least to supply a centralized panel equipped with pressure grease fittings and connected to various bearings by suitable tubing, thus making it almost impossible to miss an isolated bearing.

Dual or Tri-Purpose Oils

No simplified lubrication plan for machine tools would be complete without consideration of a special problem which arose in the case of some multiple spindle bar and chuck type automatic screw machines. This problem related to the maintenance of the correct cutting oil in these machines for it was found in some instances the machine's lubricant, and sometimes the hydraulic oil, were

diluting the cutting oil in sufficient volume to reduce the active ingredients in the cutting oil. In a few instances, the direction of the dilution was reversed; in these cases, the cutting oil being the offender by contaminating the lubricating and/or hydraulic oil, thus resulting in sludge formation, corrosion and ultimately ruined machine parts.

To overcome this situation "Dual Purpose Oils" were developed which could be used as a general machine lubricant as well as the cutting fluid on bar type automatics. Subsequently, their use was extended to the hydraulic system on chuck type automatics, resulting in their accepted classification as "Tri-Purpose Oils".

Dual or Tri-Purpose Oils are non-corrosive to steel or copper. Years of experience has shown them to function efficiently as a machine lubricant and a hydraulic fluid in these systems. In addition, they give excellent tool performance on all machining operations which are considered mild or slightly on the tough side. Even on "tough" jobs the effect of dilution from that portion used in the lubricating system will be far less than if straight mineral oil had been used in the latter.

Warning:—It is absolutely essential that only fresh clean oil be added on the lubricating side of the machine. Oil from the cutting oil sump should never be added to the lubricating oil reservoir for if it is, the chips in the latter would soon cause serious damage to the bearings.

CONCLUSION

Machine tool manufacturers are to be complimented on the ever increasing attention being given to lubrication. Many manufacturers have devoted a great deal of time and effort in order to determine the most satisfactory grades of lubricants to be used; they are very conscious of their responsibility to their customers in passing this information on to them.

Machine tool manufacturers also are designing modern tools so that a minimum of attention can be given re-lubrication. Methods used include the almost universal acceptance of centralized lubricating system with their many advantages of positive lubrication and savings in labor and maintenance costs.

The Petroleum Industry, too, is proud of the lubricants developed in recent years which make it possible to use a single product over an ever broadening range of conditions. Modern lubricants also function over much longer periods of time. Such lubricants permit the development of a simplified lubrication plan as described in this article.

TEXACO LUBRICANTS FOR MACHINE TOOLS

Parts to be Lubricated

Texaco Recommendations

HYDRAULIC SYSTEM

Low Viscosity	Texaco Regal Oil A (R&O)
Medium Viscosity	Texaco Regal Oil PC (R&O)

GENERAL MACHINE LUBRICANT

Low Viscosity	Texaco Regal Oil B (R&O)
Medium Viscosity	Texaco Regal Oil PC (R&O)
High Viscosity	Texaco Regal Oil PE (R&O)

GEARS (Not lubricated by general machine oil)

Lightly Loaded — Other Than Worm	Texaco Thuban 90 or 140
Heavily Loaded — Other Than Worm	Texaco Meropa Lubricants—3 or 6
All Worm Gears	Texaco Meropa Lubricants—3 or 6

SPINDLES

Oil Lubricated	
By Oilers and Wick Feed	Texaco Regal Oils (R&O)
By Ring Oiler	Texaco Regal Oils (R&O)
By Circulating or Flood System	Texaco Spindura or Regal Oils (R&O)
By Oil Mist	Texaco Spindura or Regal Oils (R&O)
Grease Lubricated	Texaco Regal Starfak No. 2

WAYS

Lightly Loaded	
Medium Viscosity	Texaco Regal Oil PC (R&O) or PE (R&O)
High Viscosity	Texaco Ursa Oil
Heavily Loaded or Where Chattering Occurs	
Medium Viscosity	Texaco Way Lubricant
High Viscosity	Texaco Way Lubricant

GENERAL GREASE LUBRICATION

Normal Operation	Texaco Regal Starfak No. 2
Heavy Duty Operation	{ Texaco Marfak No. 1, or Marfak No. 2 Heavy Duty

DUAL AND TRI PURPOSE OILS FOR MULTIPLE

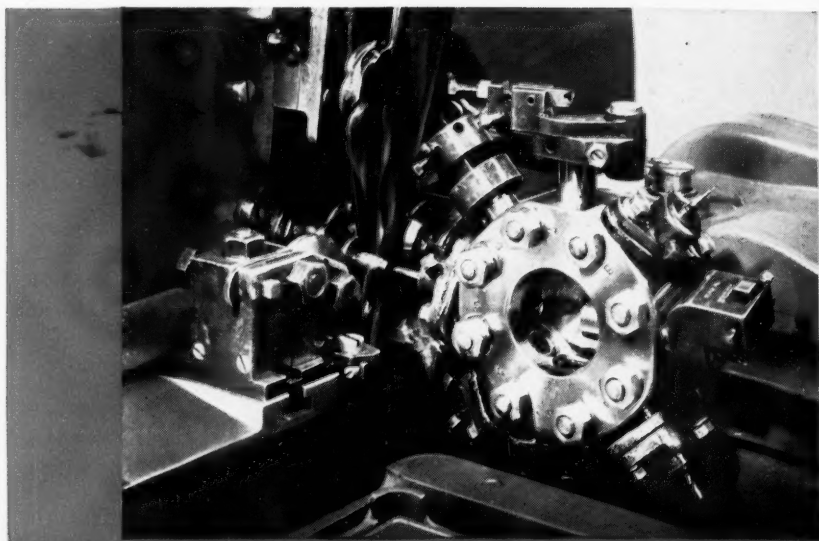
SPINDLE AUTOMATIC SCREW MACHINES

Dual Purpose — Machine Lubricant and Cutting Fluid	Texaco Cleartex Cutting Oil B
Tri Purpose — Hydraulic Fluid, Machine Lubricant and Cutting Fluid	Texaco Cleartex Cutting Oil DD

The foregoing products are of highest quality and are recommended for use where automatic or circulating system primarily prevail, as they do on most modern machines.

Texaco Lubrication Engineers are thoroughly familiar with the Simplified Lubrication Plan for Machine Tools. Let them help you simplify the number of lubricants used in your production shops.

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